# MOTION AND GESTURE INPUT FROM A WEARABLE DEVICE

## CROSS REFERENCES TO RELATED APPLICATIONS

**[0001]** This application is a continuation of U.S. patent application Ser. No. 14/973,573, filed Dec. 17, 2015 and published on Mar. 30, 2017 as U.S. Patent Publication No. US 2017/0090567, which claims the benefit of U.S. Provisional Patent Application No. 62/233,295, filed Sep. 25, 2015.

## FIELD OF THE DISCLOSURE

**[0002]** This relates generally to detecting a user's motion and gesture input to provide commands to one or more devices. In particular, a device can use one or more sensors to determine a user's motion and gesture input based on movements of the user's hand, arm, wrist, and fingers.

## BACKGROUND OF THE DISCLOSURE

**[0003]** Some existing portable electronic devices accept voice or touch input to control functionality of the devices. For example, a voice command system can map specific verbal commands to operations such as initiating a voice call with a particular contact in response to speaking the contact's name. In another example, a touch input system can map specific touch gestures to operations such as zooming out in response to a pinch gesture on a touch sensitive surface. However, there may be situations where the user's ability to speak a verbal command or perform a touch gesture may be limited.

## SUMMARY OF THE DISCLOSURE

**[0004]** This disclosure relates to detecting hand gesture input using an electronic device, such as a wearable device strapped to a wrist. The device can have multiple photodiodes, each sensing light at a different position on a surface of the device that faces skin of a user. Due to this positioning, the sensor data from the photodiodes can capture movement of anatomical features in the tissue of the user during a hand gesture. Further, different light emitters on the device can emit light at different wavelengths (e.g., infrared light, green light, etc.), which penetrate to different depths in the tissue of the user before reflecting back to the photodiodes on the device. Accordingly, sensor data from the photodiodes can capture expansion and contraction in the tissue of the user during a hand gesture. Examples of the disclosure detect hand gestures by recognizing patterns in sensor data that are characteristic of each hand gesture, as the tissue expands and contracts and anatomical features in the tissue move during the gesture.

**[0005]** In one example, the device can be trained on sensor data as the user performs a plurality of hand gestures. For example, during a first period, a user can perform a hand flap gesture and sensor data can be collected as the gesture is performed. During a second period, a user can perform a hand clench gesture and further sensor data can be collected as the gesture is performed. The sensor data can then be processed to calculate signal characteristics (e.g., peak/trough extraction, phase detection, etc., as described below) based on the sensor data for each period. The signal characteristics can then be clustered (e.g., using a clustering algorithm such as k-means clustering), including assigning some or all of the signal characteristics from the first period to a first cluster and some or all of the signal characteristics from the second period to a second cluster. The first cluster can be considered a pattern that is characteristic of the hand flap gesture that was performed during the first period, and the second cluster can be considered a pattern that is characteristic of the hand clench gesture that was performed during the second period.

**[0006]** Gesture detection can then be performed based, in part, on the clusters formed during training. Further sensor data can be collected during a third period, and signal characteristics can be calculated from that sensor data. After calculating the signal characteristics from the third period, a hand gesture can be detected based on the cluster that the signal characteristics belong to. For example, if most of the signal characteristics from the third period belong to the first cluster, then a hand flap gesture can be detected. If most of the signal characteristics from the third period belong to the second cluster, then a hand clench gesture can be detected. If most of the signal characteristics from the third period belong to a third cluster, then it can be determined that the user has not performed the first hand gesture or the second hand gesture.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0007]** For a better understanding of the various described examples, reference should be made to the Detailed Description below, in conjunction with the following drawings in which like reference numerals refer to corresponding parts throughout the figures.

**[0008]** FIGS. **1**A-**1**C illustrate an exemplary electronic device with a plurality of sensors in accordance with examples of the disclosure.

**[0009]** FIGS. **2**A-**2**D illustrate exemplary hand gestures in accordance with examples of the disclosure.

**[0010]** FIG. **3** illustrates exemplary charts of sensor data in accordance with examples of the disclosure.

**[0011]** FIGS. **4**A-**4**D illustrate two-dimensional clustering examples in accordance with examples of the disclosure.

**[0012]** FIGS. **5**A-**5**B illustrate training user interfaces in accordance with examples of the disclosure.

**[0013]** FIG. **6** illustrates an exemplary method of training for gesture detection in accordance with examples of the disclosure.

**[0014]** FIG. **7** illustrates an exemplary method of gesture detection in accordance with examples of the disclosure.

**[0015]** FIG. **8** is a block diagram illustrating a portable multifunction device with a touch-sensitive display in accordance with some examples.

## DETAILED DESCRIPTION

**[0016]** In the following description, reference is made to the accompanying drawings which form a part hereof, and in which it is shown by way of illustration specific examples that can be practiced. It is to be understood that other examples can be used and structural changes can be made without departing from the scope of the disclosed examples.

**[0017]** This disclosure relates to detecting hand gesture input using an electronic device, such as a wearable device strapped to a wrist. The device can have multiple photodiodes, each sensing light at a different position on a surface of the device that faces skin of a user. Due to this positioning, the sensor data from the photodiodes can capture